# Technology Readiness Assessment (TRA)

## *"Introduction to the NAVAIR Process"*

## Presented to DAU

## 3 April 2007

**Avionics Department National Chief Engineer (AIR-4.5)**

**Director, Independent Technical Review Office (AIR-4.0TRA)**

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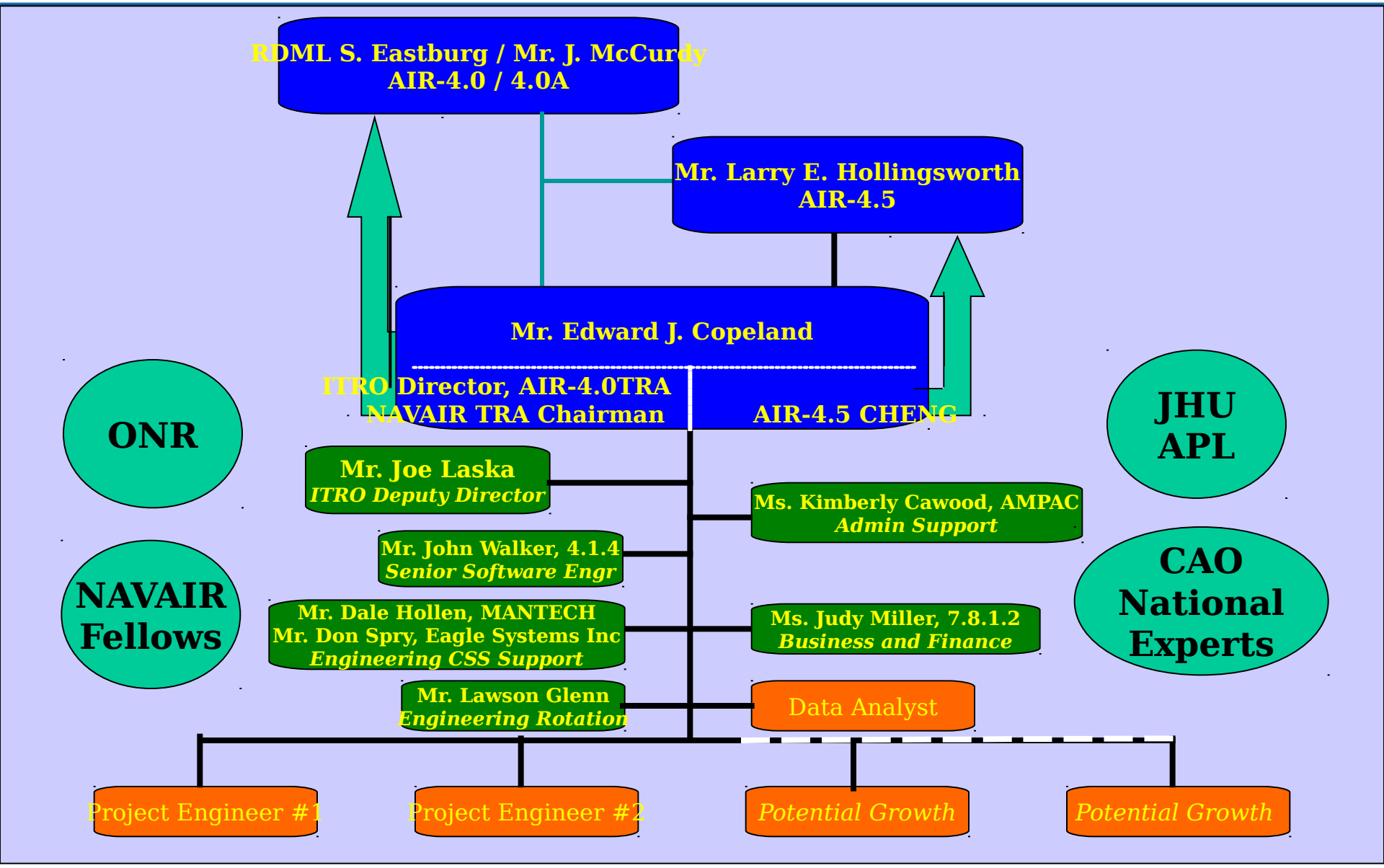
*NAVAIR TRA Chairman*

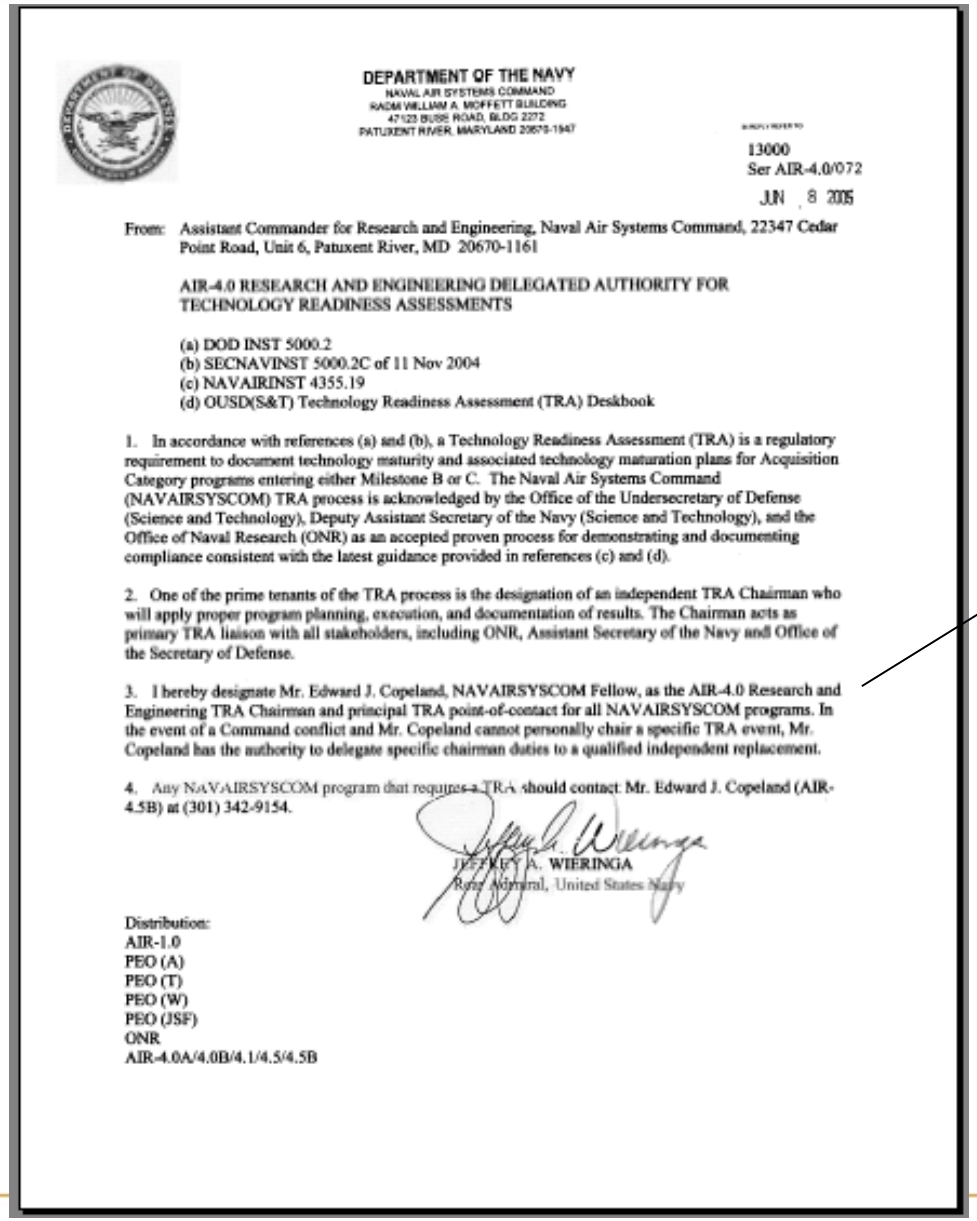
NAVAL AVIATION TECHNOLOGIES

# AIR-4.0TRA ITRO & 4.5 CHENG Team



# Brief Outline

- General Background
- Critical Technology Element
- TRA POAM Considerations
- Roles & Responsibilities
- Requirements Evolution
- TRA Process
  - CTE Reconciliation
  - CTE TRL Assessment
  - Reporting of Results
- Take Away



DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
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13000
Ser AIR-4.0/072
JUN 8 2005

From: Assistant Commander for Research and Engineering, Naval Air Systems Command, 22347 Cedar Point Road, Unit 6, Patuxent River, MD 20670-1161

AIR-4.0 RESEARCH AND ENGINEERING DELEGATED AUTHORITY FOR TECHNOLOGY READINESS ASSESSMENTS

(a) DOD INST 5000.2
(b) SECNAVINST 5000.2C of 11 Nov 2004
(c) NAVAIRINST 4355.19
(d) OUSD(S&T) Technology Readiness Assessment (TRA) Deskbook

1. In accordance with references (a) and (b), a Technology Readiness Assessment (TRA) is a regulatory requirement to document technology maturity and associated technology maturation plans for Acquisition Category programs entering either Milestone B or C. The Naval Air Systems Command (NAVAIRSYSCOM) TRA process is acknowledged by the Office of the Undersecretary of Defense (Science and Technology), Deputy Assistant Secretary of the Navy (Science and Technology), and the Office of Naval Research (ONR) as an accepted proven process for demonstrating and documenting compliance consistent with the latest guidance provided in references (c) and (d).

2. One of the prime tenants of the TRA process is the designation of an independent TRA Chairman who will apply proper program planning, execution, and documentation of results. The Chairman acts as primary TRA liaison with all stakeholders, including ONR, Assistant Secretary of the Navy and Office of the Secretary of Defense.

3. I hereby designate Mr. Edward J. Copeland, NAVAIRSYSCOM Fellow, as the AIR-4.0 Research and Engineering TRA Chairman and principal TRA point-of-contact for all NAVAIRSYSCOM programs. In the event of a Command conflict and Mr. Copeland cannot personally chair a specific TRA event, Mr. Copeland has the authority to delegate specific chairman duties to a qualified independent replacement.

4. Any NAVAIRSYSCOM program that requires a TRA should contact Mr. Edward J. Copeland (AIR-4.5B) at (301) 342-9154.

JEFFREY A. WIERINGA
Rear Admiral, United States Navy

Distribution:
AIR-1.0
PEO (A)
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AIR-4.0A/4.0B/4.1/4.5/4.5B

# AIR-4.0 Designation Letter

***"I hereby designate Mr. Edward J. Copeland, NAVAIRSYSCOM Fellow, as the AIR-4.0 Research and Engineering TRA Chairman and principal TRA point-of-contact for all NAVAIRSYSCOM programs."***

# TRAs

HLR

MMA

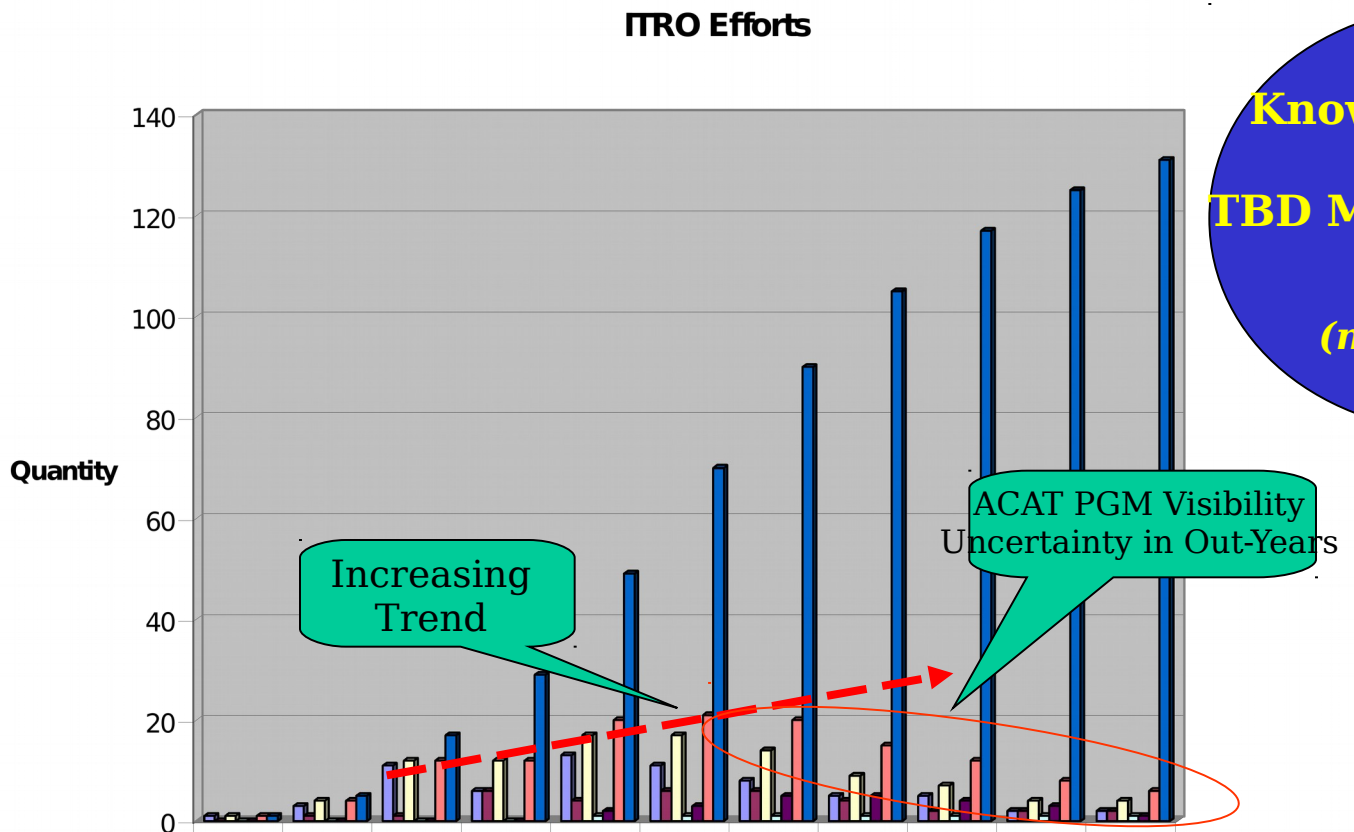
AHE

GQM-163

AESA

VXX

# ITRO TRA/TMA Activities *As of Dec 2006*




| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| New Starts | 1 | 3 | 11 | 6 | 13 | 11 | 8 | 5 | 5 | 2 | 2 |
| Continued | 0 | 1 | 1 | 6 | 4 | 6 | 6 | 4 | 2 | 2 | 2 |
| TRAs Per Year | 1 | 4 | 12 | 12 | 17 | 17 | 14 | 9 | 7 | 4 | 4 |
| Annual TMA | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Semi-An Mat Rvw | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 5 | 4 | 3 | 1 |
| Total Per Year | 1 | 4 | 12 | 12 | 20 | 21 | 20 | 15 | 12 | 8 | 6 |
| Cumm | 1 | 5 | 17 | 29 | 49 | 70 | 90 | 105 | 117 | 125 | 131 |

**Known ACAT PGM TRAs w/ TBD Milestone Dates**

**13**

***(not included)***

Consistent w/ AIR-1.0 Database Dec 2006 Run-date

NAVAL AVIATION TECHNOLOGIES

# Agenda

- General Background
- Critical Technology Element
- TRA POAM Considerations
- Roles & Responsibilities
- Requirements Evolution
- TRA Process
  - CTE Reconciliation
  - CTE TRL Assessment
  - Reporting of Results
- Take Away

# Why the Drive for TRAs ?

NAVAIR

## Most Programs Proceed With Low Levels of Knowledge Resulting in Cost/Schedule Increases

GAO
Accountability * Integrity * Reliability

In our most recent annual review of DOD programs (n=54), we found:

- Only 15% of programs began SDD with mature technology
  - programs that started with mature technologies averaged 9% cost growth and a 7 month schedule delay
  - programs that did not have mature technologies averaged 41% cost growth and a 13 month schedule delay

Non-Mature Technologies (Part of Problem):
~ Avg 32% Additional Cost Growth
~ Avg 6 Mo Additional Schedule Delay

Programs need to be more successful in achieving cost and schedule targets
~ TRA Process helps programs meet goals

# TRA Background

- NASA first established the use of Technology Readiness Levels (TRLs) in the late 1980's
  - Applied to Program Reviews
  - Evolved from 7 levels to today's 9 levels
- DoD adopted the use of TRLs for new Major programs in 2001 per DUSD(S&T/DDR&E) Memorandum
  - Response to GAO recommendation to assess technology maturity prior to technology transition
  - Established 9 levels modeled from NASA index
  - Definitions are similar but different from NASA
- DoD initial TRA guidance in 2003 per DoD TRA Deskbook
- Today DoD has referenced the importance of technology maturity in the DoD 5000 series acquisition documentation, DoD Defense Acquisition Guidebook, and the current 2005 DoD TRA Deskbook
  - Established both System/hardware TRLs and Software TRLs
  - http://www.defenselink.mil/ddre/doc/tra_deskbook_2005.pdf

# TRA, "What is it?"

- Systematic metrics based process used to assess the maturity of Critical Technology Elements (CTEs)
  - Utilizes Technology Readiness Level's (TRLs) as a metric to assess estimated CTE maturity
  - The TRA helps identify areas for program risk management, but is **Not** a Risk Assessment
  - TRA assumes a threshold compliant design and assesses the technology maturity of the elements that make up the design foundation of which the design is dependent
  - TRA addresses Hardware and Software
  - Assessment Event "Draws a Line in the Sand" for determining technology maturity
    - No credit for future accomplishments when assigning TRLs

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# Critical Technology Elements (CTEs)

- The term Critical Technology has become a universal phrase with many different connotations and definitions
  - Mission Critical Technology List
  - Critical Program Information
  - Important technologies for Mission Success
- In the context of technology readiness based on technology maturity the Critical Technology translation is unique
  - To avoid confusion and to uniquely associate the TRA application apart from the others the Critical Technology Element (CTE) terminology was born
  - CTE terminology is uniquely associated to the TRA process

# Critical Technology Elements (CTEs)

- A CTE equates to a "New" or "Novel" technology
  - Merriam – Webster Definition:
    - New ~ "new and not resembling something formally known or used"
    - Novel ~ "applies to what is not only new but strange or unprecedented"
- The "E" in CTE originated from the association of Technology Readiness Levels (TRLs)
  - TRLs are based on Elemental levels of integrated demonstrations
    - Component ➔ subsystem/system for increasing Elemental levels of demonstrated integration
    - Relevant ➔ operational for increasing elemental demonstrations in mission relatable physical/logical environments (static to dynamic)

**Critical Technology Elements: If a system being acquir**
**ends on specific technologies to meet system operatio**
**equirements in development, production, and operatio**
**f the technology or its application is either "new or no**

# Basic Criteria for Determining CTEs

**Given(s):**

- All Technologies are directly traceable to an operational threshold requirement unless included by PM as Cost Reduction Initiative (CRI) or approved performance enhancement
  - CTEs identified will be directly traceable to both an operational requirement and/or accepted PM configuration change
  - Not all operational threshold requirements are Key Performance Parameters (KPPs)
    - KPPs represent only a small subset of overall requirements set
    - Typically 100's of threshold requirements vice ~ 10 or less KPP requirements

CTEs may or may not be traceable to KPP requirements
(Requirements traceability maintained by PM)

# Basic Criteria for Determining CTEs

- If a Program has “n” CTEs
  - May or May Not be KPP related
  - CTEs may be enabling technologies, performance margin, or cost reduction initiatives that can be traded if necessary
  - CTEs may have potential non-CTE fall-back alternatives
  - CTEs could be low risk to the program

A single TRL characterization of a Program is misleading

# Basic Criteria for Determining CTEs

**Additional Given(s):**

- Technology is considered part of the product configuration baseline
  - Part of "Program of Record" being assessed
    - Directly impacts performance, affordability, manufacturing, and evolutionary spirals
  - Milestone B ~ Conceptual/Proposed design to meet threshold performance
  - Milestone C ~ Production representative configuration

# Basic Criteria for Determining CTEs

- If “Yes” then CTE: Is the technology New or Novel?
  - Note: A new product does not dictate a new technology
- If “Yes” to the following additional questions then further discussion required to determine significance before CTE determination
  - Has the technology been modified?
  - Has the technology been repackaged such that a new and more stressful relevant environment is realized?
  - Is the technology expected to operate in an environment and/or achieve a performance expectation beyond it’s original design intention or demonstrated capability?

the physics or engineering understood and scalea
from similar proven technology product families?

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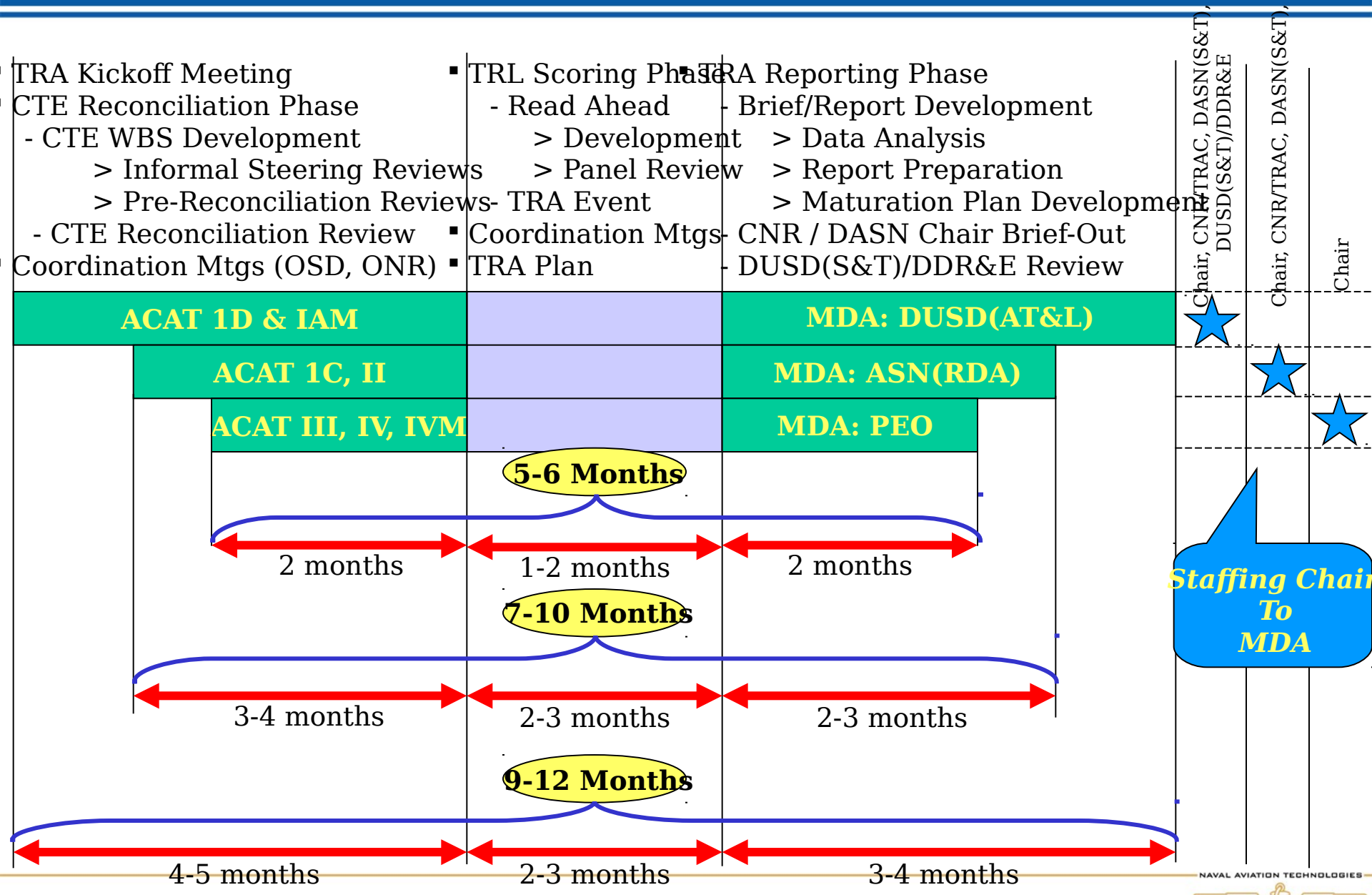
# ACAT TRA POAM Variation

NAVAIR

- TRA Kickoff Meeting
- CTE Reconciliation Phase
  - CTE WBS Development
    - > Informal Steering Reviews
    - > Pre-Reconciliation Reviews
  - CTE Reconciliation Review
- Coordination Mtgs (OSD, ONR)

- TRL Scoring Phase
  - Read Ahead
    - > Development
    - > Panel Review
  - TRA Event
- Coordination Mtgs
- TRA Plan

- TRA Reporting Phase
  - Brief/Report Development
    - > Data Analysis
    - > Report Preparation
    - > Maturation Plan Development
  - CNR / DASN Chair Brief-Out
  - DUSD(S&T)/DDR&E Review



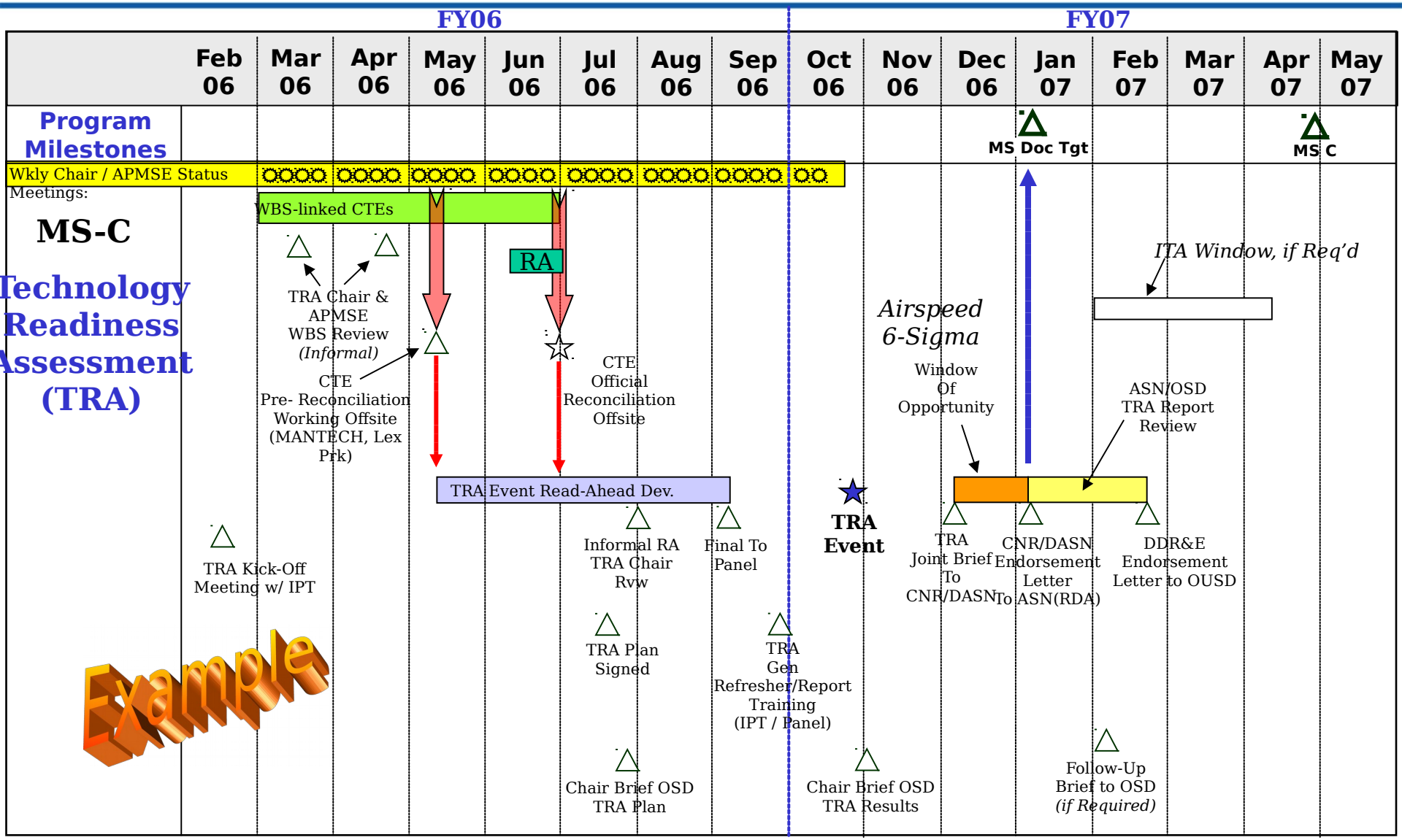

***Milestone, Calendar period & Acquisition Complexities will vary resources, time, and cost r***

# Milestone B TRA POAM Complexities Include

- Ability to Estimate w/ Confidence Conceptual Allocated Baseline Designs as Probable Proposals to RFP
- Acquisition Strategy Impacts
  - Sole Source or Open Competition ?
  - Number of Offerers ?
  - Number of Potential Choices to Address Requirements ?
  - CONOPS Available ?
  - Operational Requirements Stability ?
    - Systems Requirements Review (SRR) Timing
    - NROC, JROC, CDD, etc.
  - Joint Program ~ MOA Necessary
    - Multi-Service PEO Signatures
    - Single S&T Executive TRA
    - Single Service Secretary Endorsement
  - Spiral/Incremental Development ?
  - Contractor Pre-Development Phase or Not ?

**Impacts Influence Time & Effort Required to Complete CTE WBS and Reconcile CTEs**

# Sample ACAT-1D Program TRA POAM



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# Roles & Responsibilities (1)

NAVAIR

- Chairman
  - Establishes agreed-to schedule for TRA w/ PM & TRAC
  - Facilitates and clarifies the proper identification of Critical Technologies
    - Utilizes NAVAIR Fellows / Grey Beards in Vetting Process w/ PM IPT leads
  - Develops TRA plan and report
  - Establishes and Obtains Concurrence w/ ONR TRAC on TRA Panel
  - Coordinates and facilitates the execution of the TRA
  - Implements agreed-to process between NAVAIR and ONR
    - Utilizes NAVAIRINST 4355.19C SETR TRA Handbook, Module, & Checklist
      - Embraces DOD TRA Deskbook
  - Maintains close coordination w/ TRAC on TRA plan and report prior to submission to CNR
  - Clarifies report content w/ CNR directly if questions

# Roles & Responsibilities (2)

- ONR TRA Coordinator (TRAC)
  - CNR agent to maintain independent certification of TRA process
  - Collaborates with Chairman for ensuring adequate TRA plan, membership, and report submittal
  - Participates as equal member on TRA Panel
- Program Manager (PM)
  - Provides insight into platform CONOPS and operational requirements
  - Provides trace of operational requirements to identified critical technologies
  - Defines system concept(s) and associated architectures
  - Identifies Critical Technology Elements (CTEs) to platform WBS
  - Responsible for CTE Maturation Plans
  - Provides for access to TRA materials given sensitive and/or proprietary environment (i.e., non-disclosure, classified)
  - Prime Contractor involvement encouraged
    - Contractual language to support TRA tasks (samples available)
    - CDRLs
  - Funds TRA Efforts

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  - Reporting of Results
- Information Dissemination

# TRA Requirements F

**DODD 5000.1**
*12 May 2003*

A central theme of the acquisition process is that the technology employed should be "mature" before system development begins.

**DODI 5000.2**
*12 May 2003*

Establishes the requirement for all acquisition programs to conduct Technology Readiness Assessments (TRAs)

**Listed in Encl 3: Regulatory Info & MS Requirements**

**Defense Acquisition Guidebook**
*Nov 2004*

Introduces TRA process highlights and the use TRLs

**OUSD(S&T) TRA Desk Book**
*Mar 2005*

Provides TRA process guidelines and includes HDW and SOFT TRLs

**SECNAVINST 5000.2C**
*19 Nov 2004*

Establishes the requirement for Navy acquisition programs (ACAT I, IA, II, III, IV) to conduct Technology Readiness Assessments (TRAs)

**Listed in Encl 3: Regulatory Info & MS Requirements**

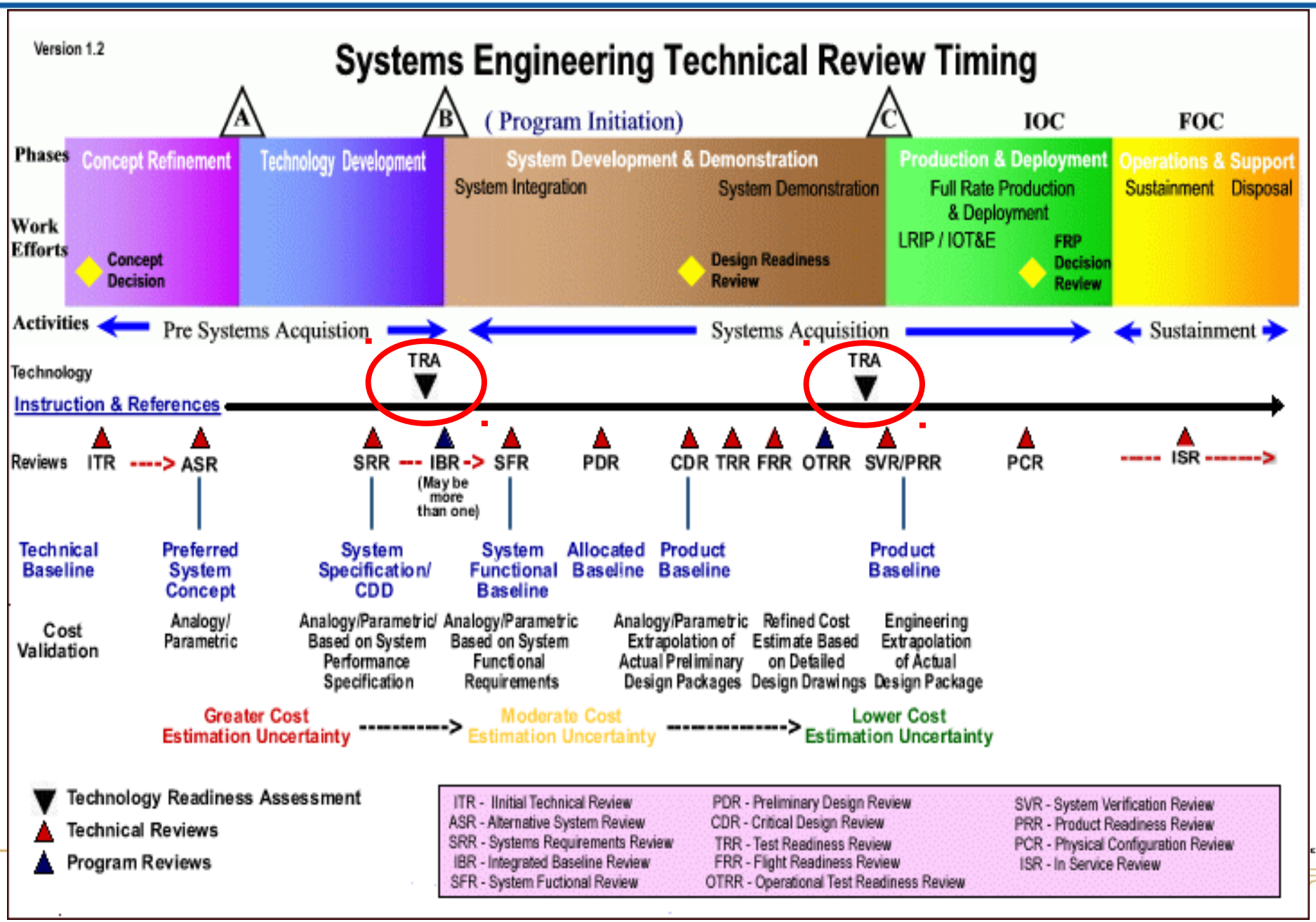
AF

ARMY

**NAVAIRINST 4355.19B**
*25 Jun 2003*

| SETR Instruction | SETR Handbook | TRA Process Module | TRA Checklist |
|---|---|---|---|

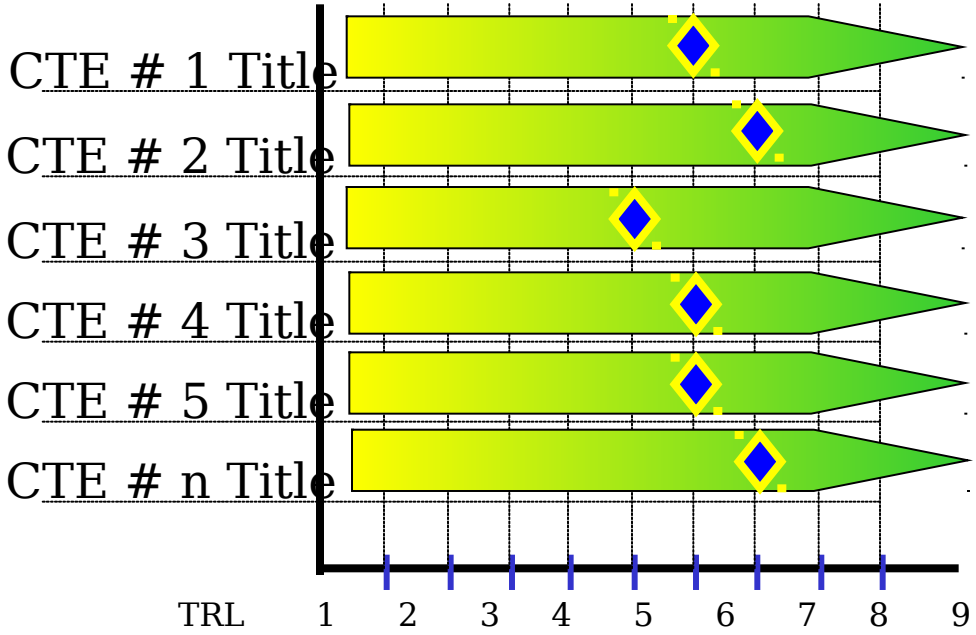
# SETR Timeline

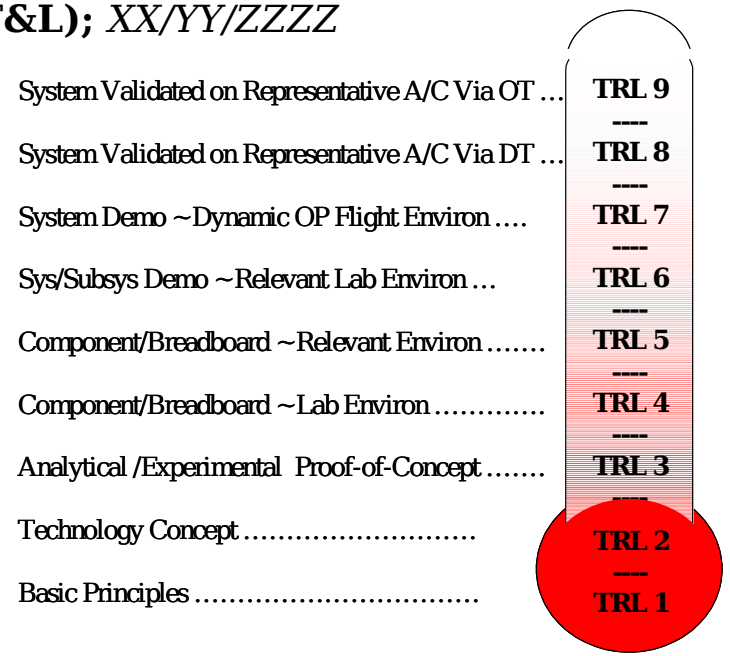


# Program TRA Status *(ACAT 1D Template)*

NAVAIR

- [x] **Contacted NAVAIR TRA Chairman to Initiate TRA Process;** *XX/YY/ZZZZ*
- [ ] **TRA CTE Reconciliation Event Complete;** *XX/YY/ZZZZ*
- [ ] **TRA TRL Scoring Event Complete;** *XX/YY/ZZZZ*
- [ ] **CTE Maturation Plans Established;** *XX/YY/ZZZZ*
- [ ] **CNR TRA Endorsement Ltr Signed & Fwd to DASN(RDT&E);** *XX/YY/ZZZZ*
- [ ] **DASN(RDT&E) TRA Endorsement Rcvd & Fwd to DUSD(S&T)/DDR&E;** *XX/YY/ZZZZ*
- [ ] **DUSD(S&T)/DDR&E TRA Ltr Signed & Fwd to DUSD(AT&L);** *XX/YY/ZZZZ*




*A Critical Technology Element (CTE) equates to a technology element, or application of a technology, considered New or Novel*

TRA Is Regulatory Req't for MS B & C
Milestone B : CTEs TRL ≥ 6 (Statute)
Milestone C : CTEs TRL = 7 (Target)

TRL = Technology Readiness Level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NAVAL AVIATION TECHNOLOGIES

# New Public Law

- HR 1815 became Public Law 109-163 as part of the National Defense Authorization Act for FY 2006
  - Public Law 109-163 contains **Section 801**

***SEC. 801. REQUIREMENT FOR CERTIFICATION BEFORE***

***MAJOR DEFENSE ACQUISITION PROGRAM MAY***

***PROCEED TO MILESTONE B.***

*(a) CERTIFICATION REQUIREMENT.—Chapter 139 of*

*title 10, United States Code, is amended by inserting after*

*section 2366 the following new section:*

***‘‘§ 2366a. Major defense acquisition programs: certification***

***required before Milestone B or Key***

***Decision Point B approval***

*‘‘(a) CERTIFICATION.—A major defense acquisition*

*program may not receive Milestone B approval, or Key*

*Decision Point B approval in the case of a space program,*

*until the milestone decision authority certifies that—*

*‘‘(1) the technology in the program has been*

*demonstrated in a relevant environment;*

Translation is Technology Readiness Level (TRL) 6

# Technology Readiness Level (TRL) 6

| Technology Readiness Level | Description |
|---|---|
| 1. Basic principles observed and reported. | Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties. |
| 2. Technology concept and/or application formulated. | Invention begins. Once basic principles are observed, practical |
| 3. Analytical and experimental critical function and/or characteristic proof of concept. | |
| 4. Component and/or breadboard validation in laboratory environment. | |
| 5. Component and/or breadboard validation in relevant environment. | elements so they can be tested in a simulated envi ples include "high fidelity" laboratory integratio ments. |
| **6. System/subsystem model or prototype demonstration in a relevant environment.** | Representativ or prototype system, which is well beyond that of TRL 5, is te in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment. |
| 7. System prototype demonstration in an operational environment. | Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft. |
| 8. Actual system completed and qualified through test and demonstration. | Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications. |
| 9. Actual system proven through successful mission operations. | Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions. |

Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.

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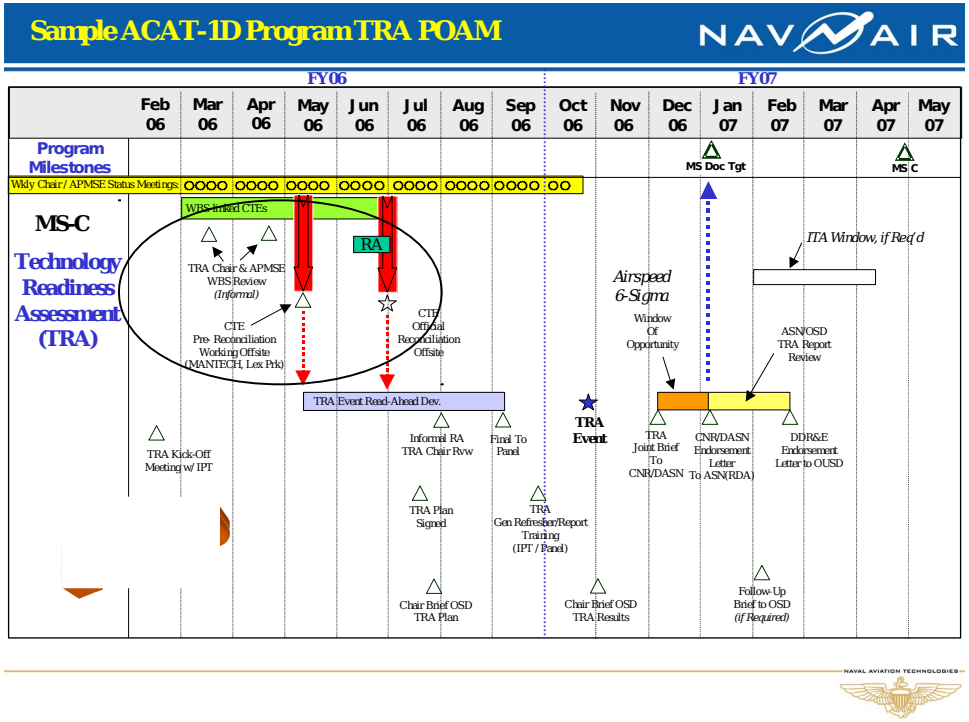
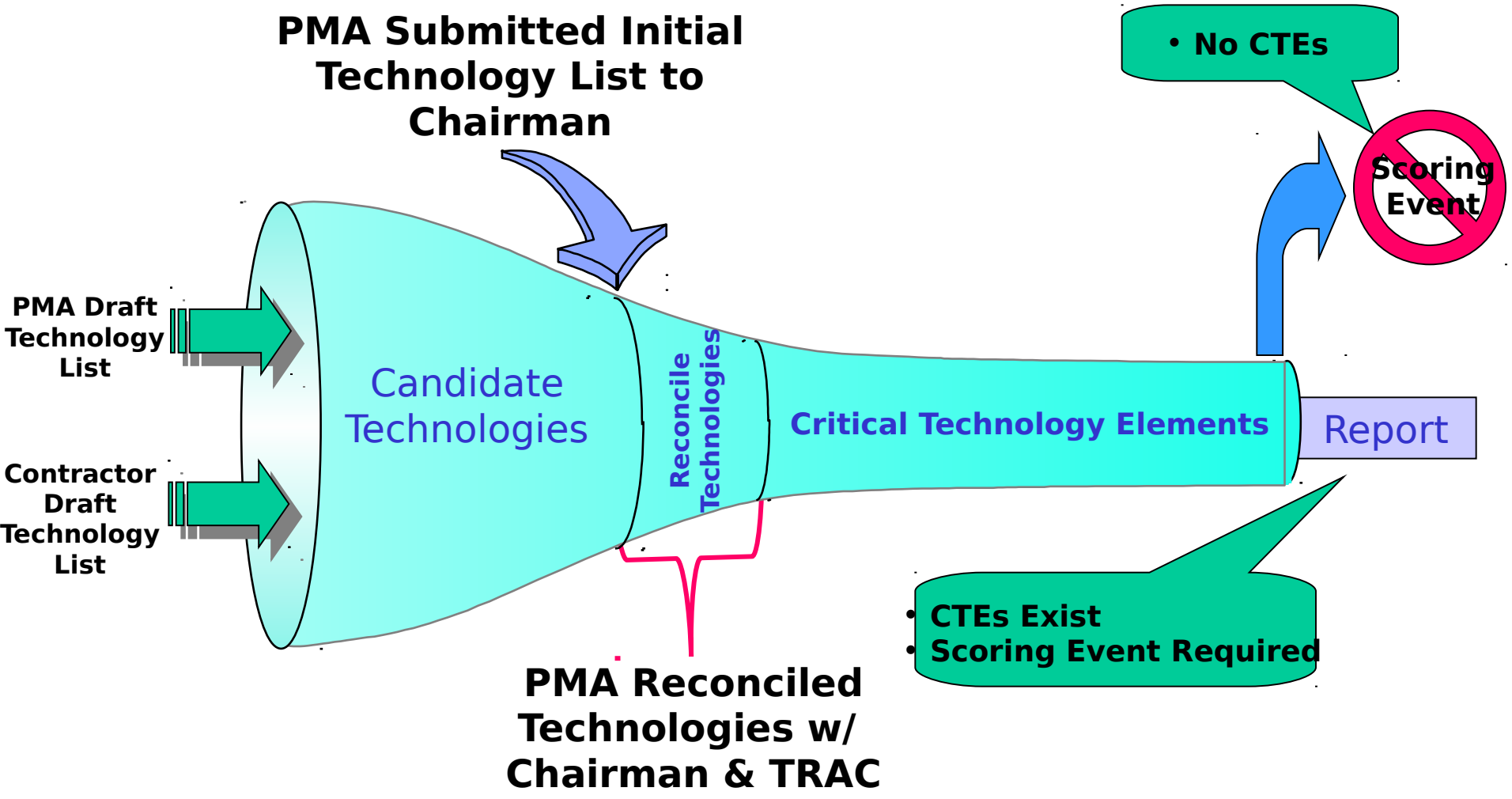
# CTE Reconciliation Phase



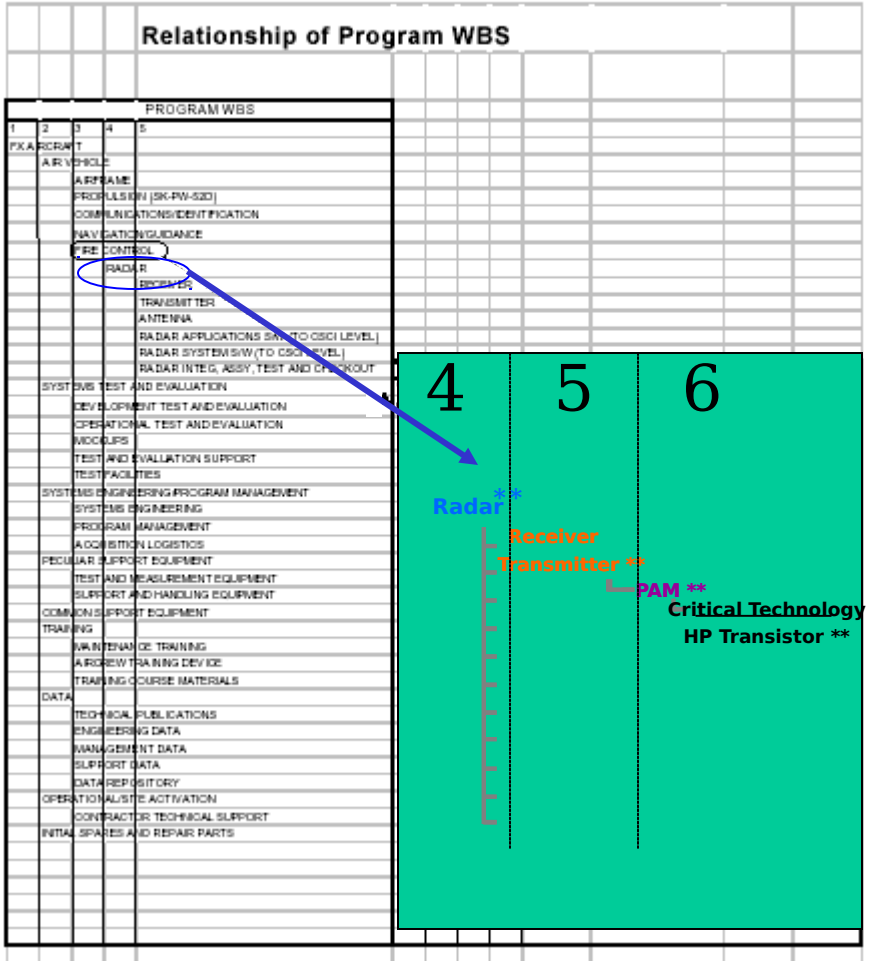

- Reconcile Critical Technology Elements (CTEs)
  - PMA IPT Fill-Out CTE WBS Addressing Template Key Questions
  - PMA IPT and Independent Panel Reconcile CTEs
    - Informal WBS Reviews
    - Pre-Reconciliation Off-Site
    - Final Reconciliation Off-Site

# CTE Pipeline Process



# WBS CTE Traceability

MIL-HDBK-881




- May require WBS lower level to identify "Critical Technology"

# Sample CTE WBS *(HLR Program)*

NAVAIR

| | A | B | C | D | E | F | G | H | I | J | K | L | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | WBS # | WBS LEVEL | WBS TITLE | WBS MAPPIN | WBS TECHNOLOGY DESCRIPTION | CTE DESCRIPTION (Describe in more | Complete / In- | NEW or | NEW APPLICA | REPACKAGED (T/M) | F | JUSTIFICATION NARRATIVE (Describe Technology for each | JUSTIFICATION NARRATIVE (Justify |
| 60 | 51 | 1.1.1.5.2 | 5 | Output (Accessories, Power Take-Off Mounts) | Secondary Pur | Technology currently used in helicopter industry. | Combined shaft and pneumatic power "Stand alone" APP. Existing Technology | Complete | N | N | N | N | Similar configuration used on SH-60B/F, S-92. Continuous operation APP demonstrated on YRAH-66 | Do not recommend as CTE. Technology currently used in industry. |
| 61 | | **1.1.1.6** | 4 | **Rotor System** | | | | | | | | | | |
| 62 | 52 | 1.1.1.6.1 | 5 | Main Rotor Blades | Rotor Syr | New Advanced Technology Composite Blade - No IBIS (BIM) - No Extender - Adv Tip - Blade De-Ice Provisions | Advanced Rotor Blade airfoils with improved lift and drag characteristics that will result in improved rotor performance are prepared for CH-53x. Advanced Rotor Blade Tip will enhance rotor lift by controlling rotor tip aerodynamics. | **In Review.** Sikorsky has predicted an increase in the rotor system figure of merit from .74 (CH-53E) to .82 (53X - 4th generation). Risk Reduction testing planned to | Y | Yes. Sikorsky has rotor performance data from the S-92 and Comanche programs. Waiting for additional tech justification of predicted enhancements. | N | Y | •Advanced airfoil and tips are needed to achieve KPP's. Technology status is laboratory. | Need maturation plan. |
| 63 | 53 | 1.1.1.6.2 | 5 | Main Rotor Head | Rotor Syr | CH-53X Advanced Technology Main Rotor Head - Ti Articulated - Automatic Electric Blade Fold - Elastomeric Blade Retention Bearings Elastomeric Rod End Bearings - Visco-Elastic Dampers | Existing technology for blade retention elements, fallback for visco-elastic damper technology. S-92 style elastomeric rotor head, fully articulated. Titanium hub, yoke, sleeve. Elastomeric blade retention & rod end bearings. Visco-elastic dampers with hydraulic damper fallback. | **In Review.** CH-53D has elastomeric rotor head. Need to determine if any issues exist with 7 blade config. | Y | Yes. This technology will be new for the 53X. | N | N | Application of existing S-92 technology for blade retention elements to CH-53X. H-60, S 76, and CH-53D elastomeric rotor heads proven with millions of flight hours. Visco-elastic dampers are in production on the NH-90 and Bell 430 main rotors and were used on the RAH-66 main rotor. CH-53X visco-elastic and fallback hydraulic dampers will be designed and built concurrently to prevent damper development issues from jeopardizing program. | I do not know if the 53x range of displacements, loads, ect are within the range of values currently used by elastomers. |
| 64 | 54 | 1.1.1.6.3 | 5 | Blade Fold System | Rotor Syr | CH-53X Automatic Blade Fold System - Electric Actuators | Automatic Blade Fold. Electric Actuators. Existing Technology | Complete | N | Y | N | N | Similar electric blade fold system has been used for 20+ years on the Seahawk and CH-46 helicopters | Do not recommend as CTE. Technology currently used in industry. |
| 65 | 55 | 1.1.1.6.4 | 5 | Swashplate | Rotor Syr | | See lower level WBS | | N | | | N | See lower level WBS | |
| 66 | 56 | 1.1.1.6.4.1 | 6 | Rotating Controls | Rotor Syr | New, Aluminum forging | Existing Technology | Complete | N | N | N | N | S/P are existing technology. | Do not recommend as CTE. Technology currently used in industry. |
| 67 | 57 | 1.1.1.6.4.2 | 6 | Non-Rotating | Rotor Syr | New, Aluminum forging | Existing Technology | Complete | N | N | N | N | S/P are existing technology. | Do not recommend as CTE. Technology currently used in industry. |
| 68 | 58 | 1.1.1.6.4.3 | 6 | Bearings | Rotor Syr | New | Existing Technology | Complete | N | N | N | N | Bearings are existing tech. | Do not recommend as CTE. Technology currently used in industry. |
| 69 | 59 | 1.1.1.6.5 | 5 | Tail Rotor Blades | Rotor Syr | New Advanced Technology Tail Rotor Blade - Composite | Tail Rotor prepared is a growth variation of the S-92 TR Blade. | **In Review.** Sikorsky has predicted an | Y | Yes. Sikorsky has rotor performance | N | N | Tail Rotor airfoil technology is well known and documented from S-92 program. Blade construction similar to CH-53E TR blade | Need maturation plan. |

Formula Bar

Sheet1 / Sheet2 / Sheet3

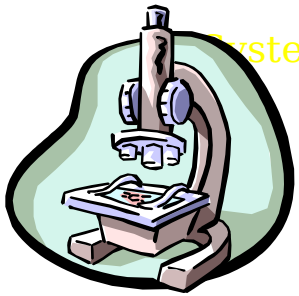
# Reconciliation of CTEs

~ Independent Expert Members + ~ Govt IPT Members + ~ Contractors

***Final Panel Membership Currently In-Work***

Work Breakdown Structure (WBS) Systematic Review

Manufacturing
Sensors
Missile Warning
Communications
Architecture
Processing
Squadron
Survivability
DIRCM
Software
R&M
Aircrew Systems
EO/IR
*Reconciliation Offsite*
Antennas
Structures
Propulsion
Electrical
Systems
Materials
Flight Vehicle Performance
Security
Information Systems
Navigation
Safety
**Logistics**
Training
Aeromechanics
* * *



Final Panel Membership Based on Resulting CTEs

Comprehensive Review

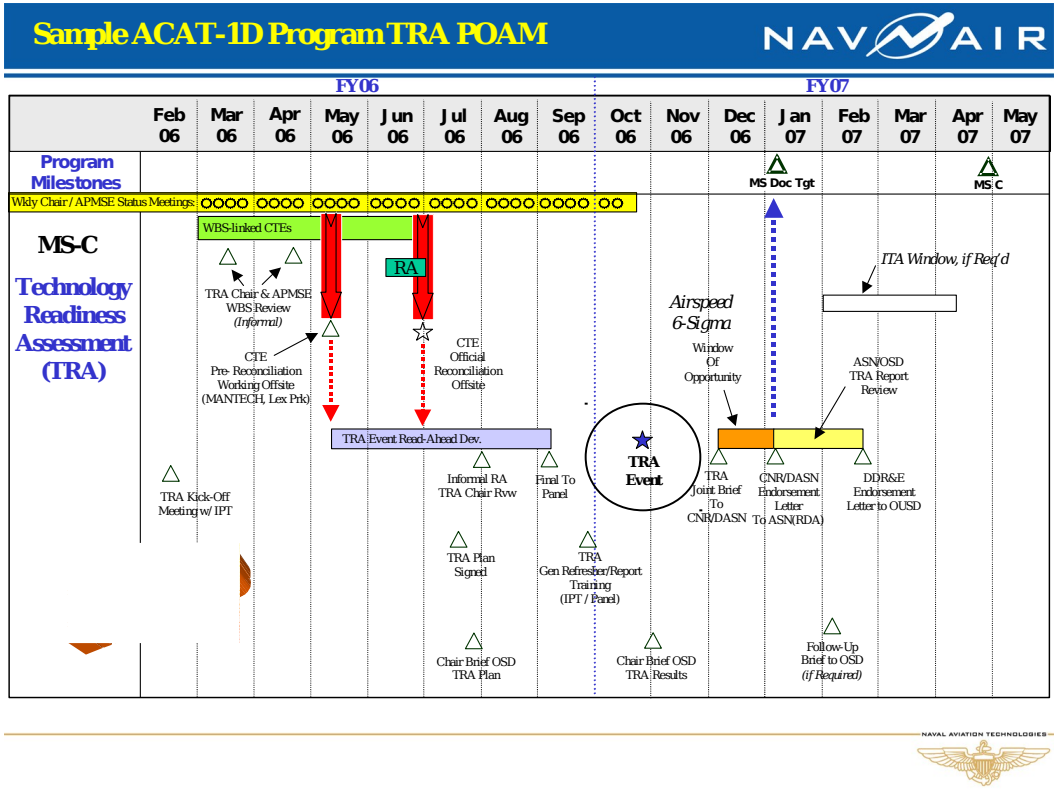
***TRA Plate***

Focused Panel Membership

# Agenda

- General Background
- Critical Technology Element
- TRA POAM Considerations
- Roles & Responsibilities
- Requirements Evolution
- TRA Process
  - CTE Reconciliation
  - CTE TRL Assessment
  - Reporting of Results
- Take Away

# TRL Scoring Event




- Score Each Justified CTE with a Technology Readiness Level (TRL)
  - PMA IPT Complete In-Work Justifications, if Necessary
  - PMA IPT Prepare Read-Ahead Briefing Material on Each CTE
  - PMA IPT Provide Read-Ahead Material to Independent Expert Panel ~ 3 Wks Prior to Event
  - Convene TRA Scoring Event Off-Site
  - Statistical Results Presented at Conclusion of Event

# TRA Scoring Event

- TRA “Draws Line in Sand” for Tech Maturity
- Only Critical Technologies Elements Addressed
- Presentations Follow Template
  - **No** Recommended TRL’s Presented
- Rater’s Review Read-Ahead Package
  - Allowing for Pre-TRA Assessment Opportunity
- Utilize Independent Expert Panel
- Demo’s & Data Available to Membership (Beneficial Opportunity) ~ Not-to-Interfere w/ TRA Execution

# TRL Characteristics *(Snapshot)*

ystem Validated on Representative A/C Via OT…

ystem Validated on Representative A/C Via DT…

ystem Demo ~ Dynamic OP Flight Environ ….

ys/Subsys Demo ~ Relevant Lab Environ …

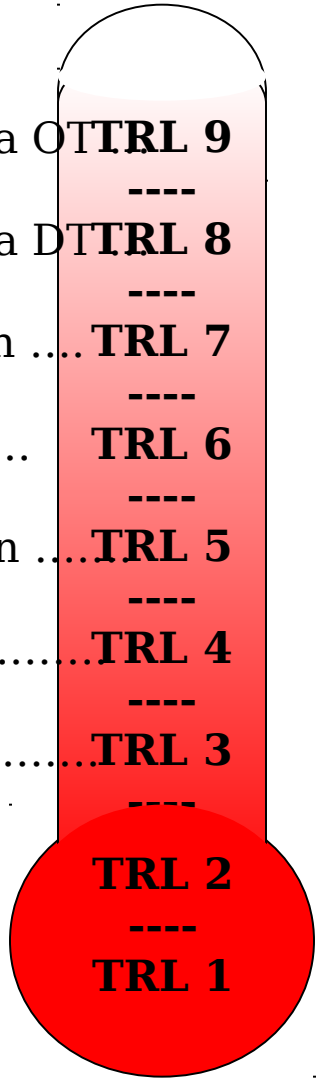
omponent/Breadboard ~ Relevant Environ ….

omponent/Breadboard ~ Lab Environ ……

nalytical /Experimental  Proof-of-Concept ……

echnology Concept ……

asic Principles ……




- System Completed
- Flt / Mission Qual
- System/Subsystem Development
- Tech Demo
- Tech Development
- Research to Prove Feasibility
- Basic Tech

# Agenda

- General Background
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# TRA Score Sheet

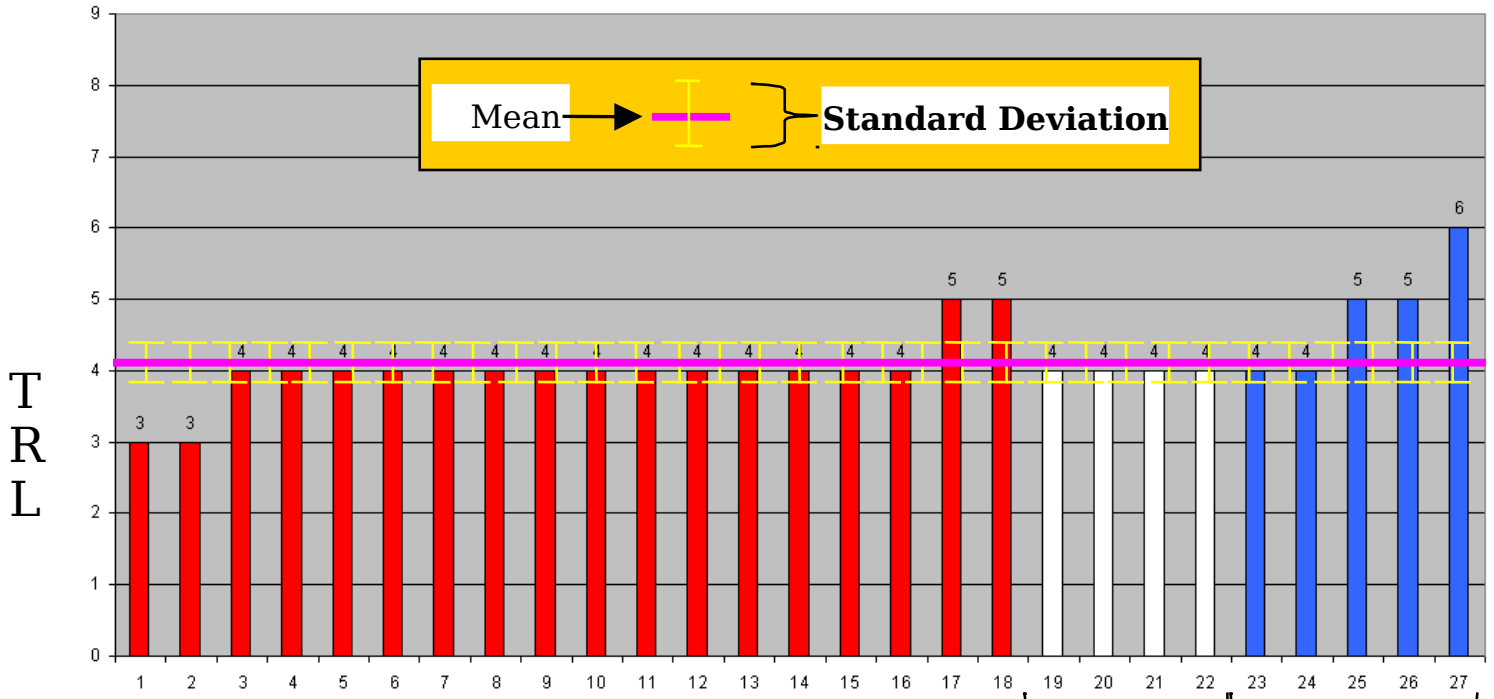
## Technology Readiness Assessment Score Sheet

| |
|---|
| **1. Name of Panel Member:** |
| **2. Technology Assessed:** |
| **3. Summary Description of Technology:** |
| **4. Circle TRL Score:** 1…..2…..3…..4…..5…..6…..7…..8…..9 *(See TRL Definitions)* |
| **5. Circle Confidence in Score:** 1Low……2……3……4……5High *(See Confidence Definitions)* |
| **6. Circle Expertise / Understanding of the technology:** 1Low……2……3……4……5High *(See Expertise/Understanding Definitions)* |
| **7. What aspects of the presentation and/or TRL definitions were most central to your TRL selection?** |
| **8. Were there any expectations that you had, that if shown by the presenter, would have raised your current score to the next TRL?** |
| **9. Can you identify any short-comings associated with or recommendations for the technology maturation plan?** |
| **10. Did lack of information or level of detail in the briefing influence your score? What additional data or detail is needed?** |

**11. What are your most important unanswered questions (relative to selecting a TRL) pertaining to the technology?**

TRA Score Sheet
Is
Same for TMA

# CTE: Advanced Paper Clip




Independent Panel
***(18 Member Votes)***

Govt XXX IPT Panel
***(4 Member Votes)***

Contractor Panel
***(5 Member Votes)***

All CTEs Require Maturation Plans

# Agenda

- General Background
- Critical Technology Element
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- TRA Process
  - CTE Reconciliation
  - CTE TRL Assessment
  - Reporting of Results
- Take Away

# Important Take Away

TRAs provide early insight to immature technologies for PMA visibility, management, and optimization of acquisition strategy ~ therefore, reducing potential for cost growth !!

# Thank You

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*Where's the Coffee??*

# Back Up Slides

# Latest DOD Instruction 5000.2

## Operation of the Defense A

(Regulatory Requirements – partial list)

| Regulatory Information Requirements Added | Reference | When Required | Comment |
|---|---|---|---|
| Initial Capabilities Document (ICD) | CJCSI 3170.01 | Concept Decision<br>MS A | NEW from Joint Staff Replaces |
| Capability Development Document (CDD) | CJCSI 3170.01 | MS B | MNS<br>NEW from Joint Staff Replaces ORD |
| Capability Production Document (CPD) | CJCSI 3170.01 | MS C | |
| Technology Readiness Assessment (PM-level) | DODI 5000.2 | MS B & C | Revised from DoD 5000.2-R requirement for an Independent Technology Assessment for all programs |
| Independent Technology Readiness Assessment (ACAT ID only - as required by DUSD(S&T)) | DODI 5000.2 | MS B & C | |
| Earned Value Management Systems | OMB Cir A-11, part 7 | See ANSI/EIA-748-1998 | From DoD 5000.2-R |

Must Do

Avoid

*Signed 19 Nov 2004*

**(Regulatory Requirements – partial list)**

| Table E3T2 REGULATORY INFORMATION AND MILESTONE REQUIREMENTS (cont'd) | | | | | |
|---|---|---|---|---|---|
| **Program Information and Reports** | **Presentation Medium** | **ACAT** | **Applicability **** | **Prepared By** | **Approved By** |
| **COMPONENT PREPARED (cont'd)** | | | | | |
| Operational Test Plan | OTA option | **IA + DOT&E oversight pgms** | Prior to start of OT&E | OTA | DOT&E |
| Program Deviation Report | PM option | **IA, II, III, IV** | Immediately upon a program deviation | PM | PM |
| Program Life-Cycle Cost Estimate | MDA option | **I, IA, II, III, IV** | Pgm Initiation for Ships<br>MS B/C, and FRP DR | PM | PM |
| Program Protection Plan (for programs with critical program information) (includes Anti-Tamper Annex) (also summarized in acquisition strategy) | Optional | **I, IA, II, III, IV** | MS B (based on approved requirements in CDD)<br>MS C | PM<br>(Annex requires CHENG's technical concurrence) | PM |
| Risk Assessment | Acqn Strat | **I, IA, II, III, IV** | Pgm Initiation for Ships<br>MS A/B/C, and FRP DR | PM | MDA |
| Systems Engineering Plan | Optional | **I, IA, II, III, IV** | Pgm Initiation for Ships<br>MS A/B/C | PM | MDA |
| System Threat Assessment (Information technology programs use published Capstone Information Operations System Threat Assessment) | Optional | **I, IA, II, III, IV** | Pgm Initiation for Ships<br>MS B/C | Intell Activity (ONI or MCIA) | Intell Activity (ONI or MCIA)<br>DIA validates ACAT ID |
| Technology Readiness Assessment | Optional | **I, IA, II, III, IV** | Pgm Initiation for Ships (preliminary assessment pre-MS B for ships)<br>MS B/C | PM | CNR (ACAT I/IA/II)<br>PEO/SYSCOM (ACAT III/IV) |

# Technology Readiness Level (TRL)

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| Technology Readiness Level | Description |
|---|---|
| 1. Basic principles observed and reported. | Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties. |
| 2. Technology concept and/or application formulated. | Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies. |
| 3. Analytical and experimental critical function and/or characteristic proof of concept. | Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative. |
| 4. Component and/or breadboard validation in laboratory environment. | Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory. |
| 5. Component and/or breadboard validation in relevant environment. | Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components. |
| 6. System/subsystem model or prototype demonstration in a relevant environment. | Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment. |
| 7. System prototype demonstration in an operational environment. | Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft. |
| 8. Actual system completed and qualified through test and demonstration. | Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications. |
| 9. Actual system proven through successful mission operations. | Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions. |

MS B Req't

MS C Target

MS C Preferred

# Software TRLs

| TRL | Definition | Description | Supporting Information |
|---|---|---|---|
| 1 | Basic principles observed and reported. | Lowest level of software technology readiness; a new software domain is being investigated by the basic research community. This level extends to the development of basic use, basic properties of software architecture, mathematical formulations and general algorithms. | Basic research activities, research articles, peer-reviewed, white papers, point papers, early lab model of basic concept maybe useful for substantiating the TRL level |
| 2 | Technology concept and/or application formulated. | Once basic principles are observed practical applications can be invented. Applications speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies using synthetic data. | Applied research activities, analytic studies, small code units, papers comparing competing technologies. |
| 3 | Analytical and experimental critical function and/or characteristic proof of concept | Active research and development is initiated. The level at which scientific feasibility is demonstrated through analytical and laboratory studies. This level extends to the development of limited functionality environments to validate critical properties and analytical predictions using nonintegrated software components and partially representative data. | Algorithms run on a surrogate processor in a laboratory environment, instrumented components operating in laboratory environment, and laboratory results showing validation of critical properties. |
| 4 | Module and/or subsystem validation in a laboratory environment, i.e. software prototype development environment | Basic software components are integrated to establish that they will work together. They are relatively primitive with regard to efficiency and robustness compared with the eventual system. Architecture development initiated to include interoperability, reliability, maintainability, extensibility, scalability, and security issues. Emulation with current/ legacy elements as appropriate. Prototypes developed to demonstrate different aspects of eventual system. | Advanced Technology Development, Standalone prototype solving a synthetic full-scale problem, or standalone prototype processing fully representative data sets. |
| 5 | Module and/or subsystem validation in a relevant environment | Level at which software technology is ready to start integration with existing systems. The Prototype implementations conform to target environment / interfaces. Experiments with realistic problems. Simulated interfaces to existing systems. System software architecture established. Algorithms run on a processor(s) with characteristics expected in the operational environment. | System architecture diagram around technology element with critical performance requirements defined, Processor selection analysis, Sim/Stim Laboratory buildup plan. Software placed under configuration management. COTS/GOTS |

# Software TRLs *(Cont)*

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| TRL | Definition | Description | Supporting Information |
|---|---|---|---|
| 6<br>MS B Req't | Module and/or subsystem validation in a relevant end-to-end environment | Level at which the engineering feasibility of a software technology is demonstrated. This level extends to laboratory prototype implementations on full-scale realistic problems in which the software technology is partially integrated with existing hardware/software systems. | Results from laboratory testing of a prototype package that is near the desired configuration in terms of performance including physical, logical, data and security interfaces. Comparisons to tested environment to operational environment analytically understood. Analysis and test measurements quantifying contribution to system-wide requirements such as throughput, scalability and reliability. Analysis of humancomputer (user environment) begun. |
| MS C Target | System prototype demonstration in an operational high fidelity environment | Level at which the program feasibility of a software technology is demonstrated. This level extends to operational environment prototype implementations where critical technical risk functionality is available for demonstration and test in which the software technology is well integrated with operational hardware/software systems. | Critical technological properties are measured against requirements in a simulated operational environment |
| MS C Preferred | Actual system completed and mission qualified through test and demonstration in an operational environment | Level at which a software technology is fully integrated with operational hardware and software systems. Software development documentation is complete. All functionality tested in simulated and operationalscenarios. | Published documentation Product technology refresh build schedule Software resource reserve measured and tracked |
| 9 | Actual system proven through successful mission proven operational capabilities | Level at which a software technology is readily repeatable and reusable. The software based on the technology is fully integrated with operat /software systems. All software documentatio cessful | Production configuration management reports Technology integrated into a reuse "wizard", out year funding established for support activity |